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METEOROLOGY IN AUSTRALIA

This article has been contributed by the Bureau of Meteorology.

In our present complex civilisation, when interests are so inter-involved and world-wide, the discovery and formulation of laws governing the weather are of first importance. To obtain an accurate meteorological system throughout Australia, the Government would be justified in incurring almost any expenditure. To all sections of the community the matter is of great importance - to those interested in commerce, in transportation, navigation. agriculture and trade of all descriptions. In short. it concerns everybody whose living and comfort depend on the weather.

(Hansard, House of Representatives, 1 August 1906)

These prophetic words were spoken during the debate on the Meteorology Bill in the Australian Parliament, itself only five years old. The Bill led to the establishment of the Commonwealth Bureau of Meteorology, which began operations as Australia's national meteorological authority on 1 January 1908.

OUR FIRST WEATHERMEN

The first observations of weather conditions around Australia by Europeans were made by Cook, Dampier and other early navigators. However, the first land-based observations were made by William Dawes, a lieutenant in the Royal Marines who arrived with the First Fleet in 1788. Dawes built an observatory at Sydney Cove and for the next three years kept daily records of wind, temperature, pressure and rainfall.

From 1800 onwards the expansion of weather information was directly related to the exploration of Australia. Men like Mitchell, Oxley, Blaxland, Lawson and Wentworth all compiled valuable weather records as they pushed back the frontiers of settlement.

Official observations in Sydney began in 1859. Activities flourished under the guidance of H. C. Russell, Government Astronomer from 1879 to 1905 who prepared Australia's first newspaper weather map, published in 1877, and initiated the publication of daily weather maps from 1879.

Melbourne's first observatory was built at Williamstown in 1854. Two years later a Bavarian scientist, Georg von Neumayer, established an observatory at Flagstaff Hill and organised a number of observing stations throughout Victoria.

Impetus to the South Australian meteorological service was given by the appointment in 1855 of Sir Charles Todd as the Director of the Adelaide Observatory. Todd was responsible for the construction of the Adelaide-Darwin overland telegraph, and a duty of all his telegraph operators was to observe and dispatch weather reports.

Perhaps the most colourful of the early Australian meteorologists was Clement Wragge, Queensland Government Meteorologist from 1887 to 1903. A man of great energy and enthusiasm, Wragge established a network of observing stations throughout Queensland and pioneered the practice of naming cyclones.

Few countries in the world, therefore, can claim as rich a heritage of foresight, wisdom and dedication on the part of their early meteorologists as can Australia. In just over 100 years after the first European settlements, an observing network over an area larger than Europe had been established, a system of preparing daily weather charts and issuing forecasts had been initiated, and a significant bank of meteorological data had been accumulated.

The Bureau of Meteorology

Victoria and Tasmania.' Generally fine' with rising temperatures .....
New South Wales: Isolated thunderstorms on the coast, chiefly north of Sydney .....
Queensland: Showers and thunder over northern parts .....
South Australia: Generally fine and warm to hot with northerly winds .....
Western Australia: Generally fine, hot in the north, cooler on the SW Coast .....
Ocean: Gales, heavy rains and rough seas off the Queensland coast .....

These forecasts for 1 January 1908 were prepared by the first Commonwealth Meteorologist, H. A. Hunt. They were published in the press, transmitted by morse code to various country centres, and indicated by a system of flags on tall buildings in metropolitan areas.

Early services consisted of one daily forecast for the States, metropolitan areas and oceans. Although it operated Australia-wide the Bureau for many years worked with very limited staff and resources. Despite this, there were several notable achievements in its early history:

1913 -staffing of Macquarie Island meteorological station as a base for Mawson's Antarctic expedition;
1921 -establishment of an observing station on remote Willis Island in the Coral Sea;
1924 -introduction of radio weather forecasts;
1934 -establishment of a meteorological office in Darwin, initially for the London to Melbourne Centenary Air Race.

The threat of war in the late 1930s saw a marked increase in the requirements for meteorological services. Staff numbers jumped dramatically. and training courses for meteorologists and observers were introduced. In 1941 the Bureau was incorporated in the Royal Australian Air Force for the duration of the War.

The post-war period was one of great expansion in the Bureau. It was an era that saw the first use of radar for upper wind measurement (1948), Australia become one of the first members of the World Meteorological Organisation (WMO) (1950), the start of continuous meteorological observations at Mawson Station in Antarctica (1954), the first television weather broadcast (1956). the first automatic weather station (1962), reception of the first TIROS satellite picture (1964). introduction of computers (1968), the beginning of regular transmissions from the Japanese geostationary satellite (1978). and introduction of a computerised communications system (1979).

Today the Bureau issues some 3,000 forecasts and warnings each day to the general community

and a wide range of special users. Weather information is provided to the public through 136 radio stations and 50 television stations, and all metropolitan and many country newspapers. In addition, about 12 million calls are made each year by the public to recorded weather information services. Forecasts and other weather information are also provided on a daily basis to the aviation industry, defence services, shipping, primary producers, offshore oil rigs, and a range of other commercial interests.

In all, the Bureau issues more than one million forecasts and warnings each year, provides more than one million aviation briefing and documentation services, and handles about half a million queries and consultations on weather forecasts and current information.

The Bureau maintains Regional Forecasting Centres in each capital city and briefing offices at most major airports and RAAF bases throughout Australia. In preparing their forecasts and warnings the Regional Forecasting Centres are supported by analyses and prognoses of the larger-scale weather patterns over the Southern Hemisphere and the tropics, produced by the Bureau's National Meteorological Centre in Melbourne, and a tropical centre in Darwin. The National Meteorological Centre also serves as one of three World Meteorological Centres (the other two are in Washington and Moscow) of the WMO World Weather Watch system.

One of the most important tasks of the Bureau is to provide warnings of dangerous weather conditions. These include tropical cyclones, floods, gales, thunderstorms, cold snaps and fire weather.

Tropical Cyclone Warning Centres are maintained in Brisbane, Darwin and Perth to locate and track tropical cyclones threatening the Australian region. The Centres are supported by a network of radar-equipped observing stations, offshore automatic weather stations, and ship and aircraft reports. In addition, the ability of meteorological satellites to pinpoint the tell-tale spiral of a cyclone means that no cyclone now goes undetected.

The Bureau operates similar specially manned centres in times of floods and bushfires to warn the public and emergency organisations.

OBSERVATIONS

Since its establishment the Bureau has been faced with the problem of obtaining adequate observations over a vast continent - equal in area to Europe or the USA - only thinly populated and surrounded by data-sparse oceans.

Over the years it has built up a network. of more than 60 Bureau-staffed stations, covering the continent and including the Antarctic and islands in the Pacific and Indian Oceans. Radar or radio-tracked balloons are used to measure wind, temperature and humidity at various levels into the stratosphere.

In addition to regular pictures of cloud imagery, polar-orbiting satellites have the capacity to sound the atmosphere, thereby providing data on temperature, moisture content and wind values at various levels above the earth's surface.

Australia's national satellite system holds great promise for meteorology through improvements in the dissemination of forecasts and collection of data from remote outback areas and unmanned weather stations. Consideration is being given to inclusion of meteorological sensors to provide forecasts with additional weather data to complement regular cloud imagery.

The Bureau-staffed network is augmented by over 400 part-time observers who provide surface weather reports several times a day, and an army of 6,000 volunteers who provide the Bureau with monthly rainfall totals. A fleet of more than 80 selected ships also radio valuable weather

data to the Bureau when they are operating in Australian waters.

Technological advances of recent years have done much to overcome the long-standing problems posed by Australia's physical size and location. In addition to the Japanese Geostationary Meteorological Satellite (GMS), which provides three-hourly pictures day and night from its vantage point 36,000 kilometres above the equator, there are American and Russian satellites in polar orbit which transmit more detailed but less frequent pictures as they pass over the Australian region. The satellites' electronics also enable them to receive and transmit weather data from remote automatic weather stations, drifting ocean buoys, and from wide-bodied jet aircraft fitted with instruments to record and transmit weather data automatically during flight.

CLIMATOLOGICAL DATA SERVICE

'An important national asset ... ' - that's the description frequently applied to the Bureau's climatological information service'. The ever-growing bank of weather data, coupled with powerful computers, enables the Bureau to provide a speedy, comprehensive climatological service to many sectors of the community - researchers in government, private industry and research institutions, atmospheric scientists, and the general public. The data include surface observations, radiation, rainfall, evaporation and upper-air measurements. Rainfall records, which form part of the data bank, have been collected for more than 100 years at some locations.

Climatological data have many applications in today's world. These include:

- urban and regional planning, such as siting of factories to minimise pollution;
- design and construction of mining townships in remote areas;
- dam construction and other water resource projects;
- assessing the need for air-conditioning:
- planning, siting and construction of airports;
- analysis of results of research projects in which weather is a factor;
- climate monitoring, including assessment of drought;
- meteorological research;
- certification of records for legal purposes.

INTERNATIONAL ACTIVITIES

Australia has played a leading part in the activities of the WMO since its formation in 1950. Bureau officers are members of many of the WMO bodies responsible for fostering the application of meteorology to aviation, shipping and agriculture, and encouraging world-wide co-operation in the establishment and maintenance of observing networks, standardisation of observational methods and the international exchange of data.

The Bureau's observations and telecommunications programs form part of the global system of the WMO World Weather Watch, and the World Meteorological Centre in Melbourne - together with centres in Washington and Moscow - provides a wide range of products for international

users.

Australia also has a number of co-operative arrangements in meteorology with other countries. Training courses are provided for overseas students, and the Bureau participates in the programs of the Australian Development Assistance Bureau. One such project involves the secondment of a number of Bureau officers to Saudi Arabia under government to government agreement, to provide management and supervisory assistance in developing the Saudi meteorological service. Another involves assistance to the Solomon Islands service through new and upgraded equipment, consumables, staff training and general scientific and technical support.

RESEARCH

The Bureau has been responsible for meteorological research since its establishment in 1908. One of the first products of this Research was a landmark publication in 1913 titled **Climate and Weather of Australia**, compiled by the then Commonwealth Meteorologist, H. A. Hunt, and two other distinguished meteorologists, Griffith Taylor and E. T. Quale.

In the following years, the Bureau's research was aimed largely at meeting the needs of operating a daily weather service. This research received a major boost during the period following World War II, when more highly qualified staff and a much improved data base became available.

The 1950s saw the establishment of a special Research and Development Division in the Bureau, and in 1965 in collaboration with the Academy of Science, the Bureau established the International Antarctic Meteorological Research Centre in Melbourne. Much research, however, was still undertaken by meteorologists engaged in operational forecasting, and related to their needs of servicing agricultural and maritime users, and issuing flood warnings and fire-weather information.

It was not until the advent of computers and the development of numerical modelling in the 1960s that research activities adopted a more specialised approach. In 1969 the Bureau joined with the CSIRO to form the Commonwealth Meteorology Research Centre (later Australian Numerical Meteorology Research Centre) which made a major contribution to the development of numerical meteorology at the international level, particularly in connection with the Global Weather Experiments of 1979.

The Bureau of Meteorology Research Centre was established in 1985 following a rationalisation of meteorological research in CSIRO and the Bureau. Its main objectives are to advance the science of meteorology, with particular emphasis on the Southern Hemisphere and the Australian region, and to support the Bureau's services by the development of operational techniques and the provision of scientific advice for other units in the Bureau.

Present and proposed research activities include:

- the development of forecasting systems for short-range (0-36 hours), medium-range (1-10 days) and long-range (1-3 months) forecasting;
- a study of weather features relevant to Australian tropical regions including research to improve predictions of formation, tracking and intensity of cyclones;
- a major collaborative effort involving the Bureau, CSIRO and universities, designed to enhance knowledge of the structure and evolution of summertime cold fronts in southern Australia;

- establishment of a program to improve the understanding of atmospheric systems that effect aviation services in Australia and development of techniques and instrumentation for identifying and forecasting those systems;

- development of a system to enable optimum use of meteorological information from satellite data and improvement of techniques for the incorporation of this data into forecasting systems.

THE FUTURE

The pioneer meteorologists who issued the Bureau's first forecasts could never have envisaged the sophisticated technology available to the forecaster today.

However, there will be even more exciting developments in meteorology by the year 2000. More advanced satellites, faster and more powerful computers, improved radar equipment, and other sophisticated technological aids will all contribute to more effective and efficient meteorological services.

These improvements will be seen in:

- more timely and accurate forecasts of short-term weather situations such as thunderstorms and cool changes;

- computer-produced graphics that will make the weather come alive on television:

- more detailed forecasts for aviation, resulting in increased economy for airlines;

- more accuracy and precision in warnings of cyclones, dangerous fire days and flood situations

- computer-produced forecasts of sea conditions, such as waves and swell, that will benefit shipping, offshore operations and the fishing industry.

Long-range forecasting is an extremely complex problem, but there are several promising lines of research that, within the next decade or so, should result in a capability for useful seasonal and longer-range predictions that will be of great benefit to farmers and others whose livelihood depends on seasonal weather conditions. Significant progress already has been made in identifying the factors that have to be monitored, with particular attention being given to the study of the variations in sea surface temperatures, atmospheric circulations and ocean currents.

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